AERONAUTICAL AND ASTRONAUTICAL ENGINEER

SIMULATION OF AEROASSISTED MANEUVERS IN THE MARTIAN ATMOSPHERE

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A spacecraft travelling from Earth on a ballistic trajectory approaches another planet at a hyperbolic velocity. Aeroassisted maneuvers such as aerocapture and aerobraking are cheaper options than propulsive capture to decelerate into orbit. In this thesis, direct entry into the atmosphere is also considered as an aeroassisted maneuver for landers and probes. This thesis strove to discover mission designer requirements for an aeroassisted maneuver tool. An AeroCAPture Simulation program, ACAPS Version 1.1, developed at the Naval Postgraduate School in MATLAB2.2 with SIMULINK2.2.1, was modified. ACAPS Version 2.2 is the result. This version is able to simulate parachute deployment, ballute release, heat shield ejection, bank angle changes and other switches in mid-flight. The user is able to enter an atmosphere profile or choose one from several options. Output data is saved and may be viewed and analyzed via built-in 2 and 3 dimensional visualization functions and plots. ACAPS Version 2.2 is expected to serve as preliminary design software at NASA's Jet Propulsion Laboratory (JPL) for the 2005 Mars Sample Return Mission and the Mars Micromissions. Ultimately, ACAPS is expected to be routinely used by JPL for preliminary mission design studies involving aeroassisted maneuvers.

DoD KEY TECHNOLOGY AREAS: Space Vehicles, Modeling and Simulation

KEYWORDS: Aerocapture Simulation (ACAPS), Aeroassist, National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory (JPL), Mars Sample Return (MSR) Mission, Mars Micromission, MATLAB, SIMULINK, Ballute, Parachute, MarsGRAM, Mars Atmosphere

MECHANICAL ENGINEER

DEVELOPMENT AND IMPLEMENTATION OF A SHELL ELEMENT WITH PRESSURE VARIATION THROUGH THE THICKNESS AND VOID GROWTH AND NUCLEATION EFFECTS

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A shell formulation was developed from a three-dimensional solid. The shell element has four corner nodes at which there are three displacements and three rotations as nodal degrees of freedom, and includes both transverse shear and transverse normal deformations. The element utilizes reduced integration along the in-plane axes and full integration along the transverse axis. The formation incorporates the Gurson constitutive model for void growth and plastic deformation. An algorithm for stable solutions of the nonlinear constitutive equations is also developed. Hourglass mode control is provided by adding a small fraction of internal force determined through full integration along the in-plane axes and reduced integration along the transverse axis. Implementation into a research finite element program is discussed. Numerical examples are provided to verify the accuracy of the new element and to show the importance of the transverse normal stress, void effects on plastic strain, and the necessity of applying a drilling moment.

DoD KEY TECHNOLOLGY AREAS: Computing and Software, Materials, Processes, and Structures, Surface/Under Surface Vehicles – Ships and Watercraft, Modeling and Simulation

KEYWORDS: Finite Element, Shell Formation, Void Model, Elasto-plastic, High Order Element